

CLAIMS

We claim:

1. A galvanic cell comprising:
 - a cathode comprising:
 - a first vesicle;
 - an electron acceptor species encapsulated into the first vesicle;
 - a first conducting substrate; and
 - a first functionalized tether immobilizing the first vesicle to the first substrate;
 - an anode comprising:
 - a second vesicle;
 - an electron donor species encapsulated into the second vesicle;
 - a second conducting substrate; and
 - a second functionalized tether immobilizing the second vesicle to the second substrate; and
 - an electrolyte in contact with both the first conducting substrate and the second conducting substrate;
 - wherein the first vesicle, the second vesicle, or both comprise one or more compounds selected from the group consisting of benzoquinone and hydroquinone.
2. The galvanic cell of claim 1, wherein the first vesicle, the second vesicle, or both comprise a material selected from the group consisting of phospholipid, quaternary amine surfactant, and vesicle-forming amphiphile.
3. The galvanic cell of claim 1, wherein the first vesicle, the second vesicle, or both comprise phospholipids having an ether, ester, or amide-linked backbone.
4. The galvanic cell of claim 1, wherein the first vesicle, the second vesicle, or both comprise phospholipids having polymerizable functionality.
5. The galvanic cell of claim 4, wherein the polymerizable functionality is located in the head-group, tail, or interfacial region of the phospholipid and is selected from the group consisting of vinyl, acetylenic, methacryl, acryl, styryl, diacetylenic,

sulfhydryl, disulfide, and dienoates.

6. The galvanic cell of claim 4, wherein the first vesicle, the second vesicle, or both are polymerized.
7. The galvanic cell of claim 1, wherein the electron donor species is selected from the group consisting of riboflavin, ascorbic acid, and ferrocyanide.
8. The galvanic cell of claim 1, wherein the electron acceptor species is selected from the group consisting of ferricyanide, superferrioxide, ferri chelates, and manganese chelates.
9. The galvanic cell of claim 1, wherein the electron acceptor species comprises a metal ion coordinated with a chelating agent.
10. The galvanic cell of claim 9, wherein the chelating agent is selected from the group consisting of glutamate, ethylenediamine tetraacetic acid, and citrate.
11. The galvanic cell of claim 1, wherein the first vesicle, the second vesicle, or both comprise an electron mediator.
12. The galvanic cell of claim 11, wherein the electron mediator is selected from the group consisting of benzoquinone, vitamin K, ubiquinone, anthroquinone, ferrocene, and caroviolegen.
13. The galvanic cell of claim 1, wherein the first vesicle, the second vesicle, or both comprise an organic cationic carrier.
14. The galvanic cell of claim 13, wherein the organic cationic carrier is selected from the group consisting of nigericin, monensin, gramicidin, lasalocid, calcimycin, and ionomycin.
15. The galvanic cell of claim 1, wherein the first conducting substrate, the second

conducting substrate, or both comprise a material selected from the group consisting of metal, polymer, and alloy.

16. The galvanic cell of claim 1, wherein the first conducting substrate, the second conducting substrate, or both comprise a material selected from the group consisting of gold, silver, palladium, platinum, rhodium, tin, polypyrrole, polyaniline, and indium titanium oxide.
17. The galvanic cell of claim 1, wherein the first conducting substrate, the second conducting substrate, or both comprise gold.
18. The galvanic cell of claim 1, wherein the first functionalized tether, the second functionalized tether, or both comprise saturated aliphatic.
19. The galvanic cell of claim 18, wherein the saturated aliphatic tether is selected from the group consisting of ethyl, propyl, butyl, pentyl, and hexyl.
20. The galvanic cell of claim 1, wherein the first functionalized tether, the second functionalized tether, or both comprise a functionality selected from the group consisting of conjugated polyene, non-conjugated polyene, polyacetylene, and polyphenylacetylene.
21. The galvanic cell of claim 1, wherein the first functionalized tether, the second functionalized tether, or both comprise a terminal functional group capable of binding to the first conducting substrate, the second conducting substrate, or both.
22. The galvanic cell of claim 21, wherein the terminal functional group is a coupling species selected from the group consisting of sulfhydryl, disulfide, amide, ester, and isocyanate.
23. The galvanic cell of claim 1, wherein the electrolyte comprises a salt bridge.
24. The galvanic cell of claim 1, further comprising a fluorescent dye electrically connected

to the first conducting substrate and the second conducting substrate.

25. A device comprising two or more of the galvanic cells of claim 1, wherein the cells are connected in parallel.
26. A device comprising two or more of the galvanic cells of claim 1, wherein the cells are connected in series.
27. A device comprising three or more of the galvanic cells of claim 1, wherein the cells are connected in series and parallel.